Sol-Gel Glasses

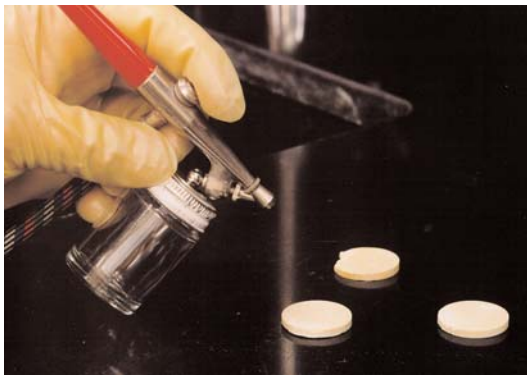
Manufacturing Technologies

The Manufacturing Science & Technology Center conducts process development and scale-up of ceramic and glass materials prepared by the sol-gel process. Sol-gel processing uses solutions prepared at low temperature rather than high temperature powder processing to make materials with controlled properties. A precursor sol-gel solution (sol) is either poured into a mold and allowed to gel or is diluted and applied to a substrate by spinning, dipping, spraying, electrophoresis, inkjet printing or roll coating. Controlled drying of the wet gel results in either a ceramic or glass bulk part or a thin film on a glass, plastic, ceramic or metal substrate. Sol-gel derived materials have diverse applications in optics, electronics, energy, space, sensors and separation technology.

The department also makes highly porous bulk and thin film aerogels using a sol-gel process. These novel materials have unique properties (>90% porosity, ultra-low density, low thermal conductivity) that lead to applications as acoustic insulation, highly efficient inorganic insulation, low K dielectrics and as inert porous matrices for sensors or optics.

Capabilities

- Formulate and produce single and multicomponent glass and ceramic materials with controlled porosity (templated or non-templated) by low temperature solution chemical polymerization (sol-gel techniques)
- Deposit sol-gel thin films by spinning, dipping, spraying, electrophoresis, ink jet printing or roll coating for reflection control, planarization, protection, dielectric barriers, enhanced surface conductivity, inert porous matrix for sensors or surface modification
- Produce ultra-low density (<150 mg/cc) bulk aerogel glass by either CO_2 solvent exchange and supercritical solvent removal or low temperature/pressure (LTP) processing. Thin aerogel films can be deposited on substrates by the LTP process
- Entrain particles, optically active compounds and chemically selective reagents into sol-gel films or controlled porosity bulk sol-gels (aerogels or xerogels)
- Perform process development and scale-up of laboratory research processes



Coating with Sol-Gel glasses

Resources

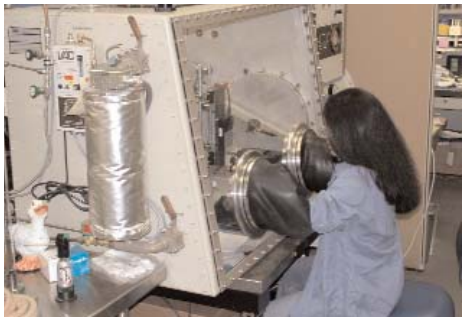
- Chemical laboratory and equipment necessary for the sol-gel synthesis and characterization of ceramic and glass materials

National Nuclear Security Administration

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company,for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

Sandia National Laboratories

- An ellipsometer to measure the thickness and refractive index of deposited sol-gel films
- Test equipment for precision glass analysis (DTA, DSC, and dilatometer) and sol-gel thin film optical properties (IR and visible reflectance and transmission)
- Glove boxes for controlled atmosphere deposition of sol-gel films by computer controlled dip coaters or spin coaters



- Prototype roll coater
- Aerogel machining
- Close collaboration with the sol-gel materials research groups at Sandia and the University of New Mexico

Accomplishments

- Demonstrated the volume expansion (spring back) of aerogels made from the LTP process allowing net-shaping of bulk aerogels, minimizing or eliminating aerogel machining in some applications
- Developed a technique to mass-produce small volumes of insulating aerogel beads
- Deposited LTP aerogel thin films by dip coating
- Deposited anti-reflective sol-gel coatings by dip coating on the inside and outside of 10 foot long x 2.5 inch diameter glass tubes
- Improved the specular reflectance by sol-gel planarizing the metal substrate of a first surface mirror
- Sandia sol-gel protected first surface mirrors were included in Space Shuttle material evaluation experiments
- Developed system to spray coat a protective sol-gel film on a 6-inch wide web moving at 20 feet per minute
- Incorporated phosphor particles and carbon particles into aerogels for radioluminescent lighting and high performance thermal insulation, which demonstrated record setting brightness for a tritium-powered light
- Developed a technique to spin coat a low porosity sol-gel glass film on the inside of an alumina gas separation membrane tube
- Numerous patents issued

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